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Malik Ghulam Sarwar
Barari Forest Management, United Arab Emirates, sarwargh2002@yahoo.com

Fakhar -i- Abbas
Bioresource Research Centre, Islamabad, Pakistan

Inayat Ali Shahjehan
University of Peshawar, Pakistan

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DISTRIBUTION AND HABITAT ANALYSIS FOR FRESHWATER TURTLES OF RIVER INDUS AND SOME OF ITS TRIBUTARIES IN KHYBER PAKHTUNKHWA AND PUNJAB, PAKISTAN

Malik Ghulam Sarwar[1], Fakhar-i-Abbas[2] and Inayat Ali Shahjehan[3]
[1] Barari Forest Management, Abu Dhabi, UAE
[2] Bioresource Research Centre, 34-Bazaar Road, G-6/4, Islamabad, Pakistan
[3] Department of Zoology, University of Peshawar, Pakistan

Email: sarwargh2002@yahoo.com

ABSTRACT

This study was conducted to investigate the relative abundance and habitat analysis of freshwater turtles of Pakistan. Eighty two individuals of seven species of turtles at sixteen different sites in River Indus and some of its tributaries in Khyber Pakhtunkhwa (KP) and Punjab were recorded; these include both soft and hard shell freshwater turtles. The species documented were, *Kachuga smithii*, *Kachuga tecta*, *Geoclemys hamiltonii*, *Aspideretes gangeticus*, *Aspideretes hurrum*, *Chitra indica and Lissemys punctata***.** The *L. punctata* was the most common, with relative frequency (RF) of 24.4%, followed by *A. gangeticus* (18.3%), *A. hurum* (17.1%), *C. indica* (17.1%), *K. smithii* (12.2%), *K. tecta* (7.3%), and *G. hamiltonii* (3.7%). It was also discovered that District Swabi was the most populous area with three densely populated sites; Yar Hussian stream, Allah Dher River and Badri stream. In order to know the habitat preferences the biotic and abiotic factors of water bodies within the freshwater turtle's habitat (16 study sites) were also measured. Abiotic factors *viz.* pH ranges from slightly acidic to basic (6.90-9.43), total dissolved solids (0.28-5.07 mg/L), conductivity (7.33-26.33 mv), dissolved oxygen (0.67-16.40 mg/L), temperature of air (20°C - 40°C) and temperature of water (19°C - 34°C) were recorded. Besides, biotic components including, twenty seven genera of Phytoplankton and sixteen genera of Zooplanktons were also observed in study area.

Keywords: *Hardella thurjii*, Freshwater turtles, Freshwater ecosystem. River Indus.

INTRODUCTION

Freshwater ecosystem may well be the most endangered ecosystem in the world and its biodiversity decline is much higher than highly affected terrestrial ecosystems. Turtles and tortoises are major biodiversity components of our environment and outstanding gauge of the quality and health of the habitat in which they live (Turtle Conservation Fund 2003). Two hundred taxa of living freshwater turtles and tortoises are listed as threatened from total of approximately 300 species. Asia having the greatest percentage of threatened species, with more than 75% Critically Endangered, Endangered, or Vulnerable, and 91% included in the IUCN Red List (IUCN, 2015). Survivors of million years, turtles in our millennium are in jeopardy due to many problems such as collected for pet trade, butchered for bones, flesh eaten, professed medical use and traded in devastating numbers. Similarly, agricultural and developmental activities destructed or altered turtle's habitat affecting turtle populations. Many species of the turtles and tortoises globally will become extinct within the next few decades due to lack of concerted conservation action (Turtle Conservation Fund, 2003)**.** Turtles are in alarming conservation need because of their

life history includes low reproductive output, late maturity, and habitat requirement of wetlands and terrestrial environments (Cogdon and Gibbons, 1997; Klemens, 2000; Gong *et al*., 2006).

Pakistani turtles and tortoise species are represented by five families *viz*. family Cheloniidae with four sea turtle species (*Caretta caretta, Chelonian mydas*, *Eretmochelys imbricate* and *Lepidochelys olivacea)*; family Dermochelyidae represented by single sea turtle specie, *Dermochelys coriacea*; family Testudinidae with two land tortoise species (*Agronemys horsfieldii* and *Geochelon elegans*) and eight species of freshwater turtles; family Emididae with four species (*Geoclemys hamiltonii, Kachuga smithii, Kachuga tecta* and *Hardella thurjii),* while family Trionychidae represented by four species (*Chitra indica, Aspideretes gangeticus, Aspideretes hurum* and *Lissemys punctata andersonii)* (Khan, 2006). Due to above mentioned threats to freshwater turtle populations CITES (Convention on International Trade in Endangered Species) of Wild Fauna and Flora listed these turtles in their appendix I & II (Anonymous 2015). Similarly, according to IUCN Red list (2015) Indian Narrow Headed Soft shelled Turtle (*Chitra indica*) is endangered; Spotted Pond Turtle (*Geoclemys hamiltonii*), Crowned River Turtle (*Hardella thurjii*)and Ganges Soft shelled Turtle (*Aspideretes gangeticus*) are vulnerable; Smith's Turtle (*Kachuga smithii*)is of low risk or near threatened; Indian Roofed Turtle (*Kachuga tecta*) is of low risk or least concern and Peacock Soft shelled turtle (*Aspideretes hurum*) is data deficient (IUCN 2000). There are about three hundred living species of turtles and tortoises, which are found in different habitats of the world (Gong *et al*., 2006). The number of reptile species recorded from Pakistan has risen steadily from 144 species reported in 1966 to the present number 235 (Khan, 2006). Biology, distribution and status of freshwater turtles are less known in Pakistan and are described by Smith (1935), Minton (1966), Mertins (1969), Akbar *et al.*, (2006) and Azam *et al.*, (2005). Better productivity of these species depends on the physicochemical characteristics, quality and quantity of phytoplankton and zooplankton of the water body (Boyd, 1981).

Considering all the above mentioned factors, in present study some aspects of ecology and distribution of various freshwater turtle species along with habitat condition in terms of physico-chemical and biological (planktonic) characteristics were evaluated. Information gathered as the results of this study will be compared among different species involved in this study. Furthermore, this study is designed to know; the distribution of freshwater turtles in Punjab and Khyber Pakhtunkhwa along River Indus and its tributaries and habitat preferences by estimating some physico-chemical and biological components in potential freshwater turtles' habitat.

METHODOLOGY

Study Area

This study was conducted on river Indus, its tributaries, nullahs and dams of Potohar region and some of important streams of Khyber Pakhtunkhwa (KPK), Pakistan (Figure 1). The sampling sites were potential habitats of freshwater turtles and were easily accessible.

Distribution and Population Estimation

The study was conducted from March, 2007 till July, 2008. Each selected area of water body was divided into three equal

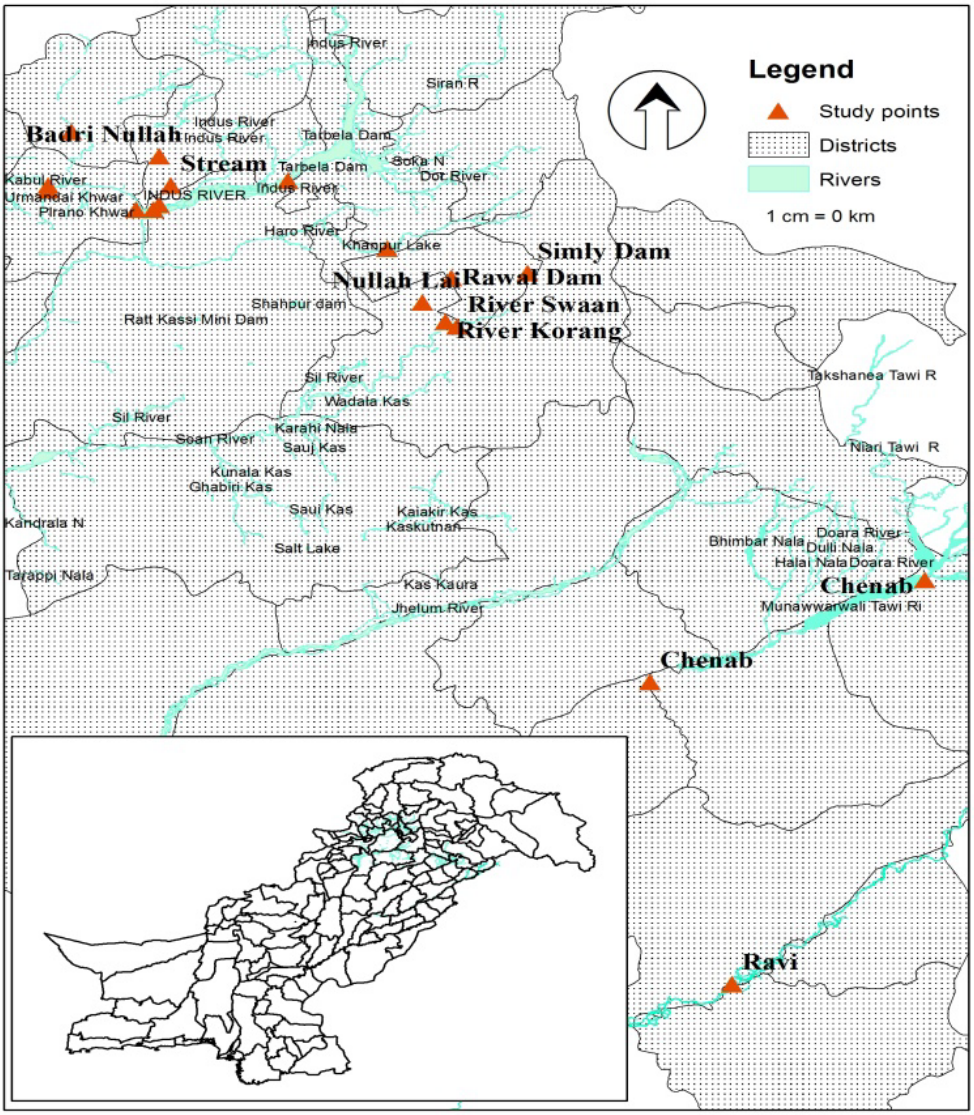

Figure 1: Map showing sampling sites of freshwater turtles (the location of study sites is given in Table 1) (source: Arc View 3.3 and Google Earth 2009).

quadrates (approximately 50 m^2). Each quadrate was then observed after one hour interval and turtles at visible depth and at surface were counted. The average of three quadrates contributes to estimate of population of turtles at particular site. Moreover, each site of water bodies was walked about 0.5 km to 1 km along banks and adjoining areas to locate turtles. The basking turtles were observed, counted and identified. The hand collection method was adopted for turtle collection. For imaging and detailed study Olympus digital camera (Model C-765 ultra-zoom) was used. Further morphological study for identification of species and sex were also done (Minton 1966, Khan 2006). The relative abundance and frequency of occurrence were calculated for each site and species (Akbar et al. 2006).

Habitat Analysis

Abiotic Factors

During the survey of each selected potential habitat site, water samples were

analysed visually for its colour, taste, odour and turbidity. The temperature of both air and water was recorded with the help of ordinary mercury thermometer. Conductivity, dissolved oxygen (DO) and pH of water were determined with the help of conductivity meter (model CD 600 series), dissolved oxygen test kit (HI 3810, HANNA ISO-9001) and pH meter (HANNA ISO-9001), respectively. Total dissolved solids (TDS) were measured by methods described by Boyd and Tucker 1998.

Biotic Factors

The water samples for recording the phytoplanktons and zooplanktons were taken from the subsurface in plastic bottles and were preserved by using 4 % formalin solution and were carried to the lab for microscopic analysis for identification at 400 X (10 X ocular and 40X objective) using the key provided by Ward and Whipple 1959 and APHA 1989. Relative abundance (% by number) and frequency of occurrence (%) of plankton were calculated (Ali *et al.,* 2005). Diversity index of planktons of each site was calculated by using the following formula suggested by Boyd 1981.

$$\text{Diversity Index } (H) = \frac{S-1}{\ln N}$$

RESULTS AND DISCUSSION

Distribution and Relative Abundance

Out of 18 selected potential habitat sites sixteen showed the turtle's population. Total of 82 specimens were found on these 16 sites, categorized into 7 species *viz. Kachuga smithii, Kachuga tecta, Geoclemys hamiltonii, Aspideretes gangeticus, Aspideretes hurrum, Chitra indica and Lissemys punctate*. Table 1, provides information about the population structure i.e. number of male, female and juvenile along with the relative frequency (RF) of each turtle species found in the study sites. The most abundant species is *L. punctata* with RF of 24.4% and RA of 55.5%, while *G. hamiltonii* (RF = 3.7%, RA = 11.1%) is the rare species among all the seven species found in the study area from March, 2007 till July, 2008. Similarly, Khan (2006) reported the widespread status of all of the four soft-shell freshwater turtles throughout Pakistan. During this study in the water bodies of Northern KP only soft-shell turtles were found but in Punjab all soft and hard shell freshwater turtles were found (Yousaf and Manzoor, 2014). Akbar *et al.,* (2006) reported the existence of hard

Table 1: The relative frequency (RF), relative abundance (RA) and number of adults and juveniles of each species recorded from study sites during the period March, 2007 to July, 2008.

Scientific Name	Common Names	M	F	J	Total	RF	RA
Kachuga smithii	Brown river turtle	5	3	2	10	12.2	16.7
Kachuga tecta	Indian Saw-backed turtle	-	3	3	6	7.3	16.7
Geoclemys hamiltonii	Spotted pond turtle	-	1	2	3	3.7	11.1
Aspideretes gangeticus	Indian soft shelled Turtle	6	4	5	15	18.3	50.0
Aspideretes hurum	Peacock soft shelled turtle	7	6	1	14	17.1	50.0
Chitra indica	Narrow-headed soft shelled turtle	7	5	2	14	17.1	44.4
Lissemys punctata	Indian flap-shell turtle	5	11	4	20	24.4	55.5
Total		**30**	**33**	**19**	**82**		
RF (%)		**36.6**	**40.2**	**23.2**			

shell freshwater turtles in Punjab. *Hardella thurjii* is the only species of eight freshwater turtle of Pakistan was not located during the study period. Khan (2006) reported its distribution in Sindh province and around Karachi city. While Akbar *et al.,* (2006) located *Hardella thurjii* only on Head Trimmu in River Chenab. Khan (1999) reported two species of tortoises (i) *Geochelon elegans* from Sindh and (ii) *Agrionemys horsfieldii* from Baluchistan and Waziristan; similarly during the present study no tortoise was sighted or reported in the study area.

L. punctata found abundantly at Allah Dher (AI; Indus), *C. indica* at Badri Nullah (BN; stream) and Kalpani Nullah (KN; stream), *A. hurum* at Yar Hussain Khowar (YK; stream), *A. gangeticus* at (AI; Indus), *G. hamiltonii* at (KR; Korang), *K. smithii* at Head Balloki (HB; Ravi) and *K. tecta* at Head Marala, Qadir Abad and Balloki (HM and HQ; Chenab and HB; Ravi) with equal number. The total number of turtles found varied among different study sites ranging from zero to 12 (RA (%) = 0.0 – 14.6) (Table 2). District Swabi was the most populous area including three densely populated sites Yar Hussain Khowar (stream), Allah Dher (River Indus) and Badri Nullah (stream) with turtle's abundance 14.6%, 13.4% and 12.2% respectively, (Table 2). Relative frequencies of juveniles (23.2%) and overall adults is 76.8% with 36.6% males and 40.2% females in a ratio of 1:1 (Table 1).

Habitat Analysis

The selected potential habitat sites were analysed by measuring their different biotic and abiotic factors.

Abiotic Factors

The data on physical and chemical parameters of water bodies among all study sites has been presented in Table 3. The results of water quality parameters obtained during this study are comparable to the studies conducted on other water bodies which are potential habitat for fresh water turtles (Mirza and Khuhawar 2006, Sarwar et al. 2006, Ali et al. 2000, Tassduqe et al. 2003). It has been also observed that air and water temperature has direct relationship with fresh water turtle population and it varies spatially and temporally (Mirza et al. 2013).

In the present investigation electrical conductivity values ranged from 26.33 – 7.33 mv. The high electrical conductivity values favoured less dissolved oxygen in the water body. Therefore, it is considered good indicator of the water quality (Abbasi et al. 1996). The highest value of electrical conductivity on Nullah Lai site supported less DO which in turn affected the plankton production and results in rare turtle's population. Gaikwand et al. 2008 reported the similar results that the dilution of solids reduces the value of electrical conductivity which in turn affect the zooplankton production. Dissolved oxygen (DO) is an important aquatic parameter whose measurement is vital in the context of culture of any aquatic animal. Throughout the study area during the present research work the dissolved oxygen range remained 16.40 – 0.67 mgl^{-1}. It was noted during the study, the sites with less DO favoured less plankton production. The pH range which suits to the most of aquaculture practices was 6.5 - 9.0. During the present study pH range was 9.43 to 6.90. The range values for total dissolved solids noticed between 5.07 to 0.28 mg/L. The similar findings have been observed by Salam et al. 2000.

Table 2: Population distribution of freshwater turtles in study area during study period.

Location codes	Number of Turtles Observed							Total	RA (%)
	K. smithii	***K. tecta***	***G. hamiltonii***	***A. gangeticus***	***A. hurum***	***C. indica***	***L. punctata***		
KR	-	-	2	-	-	-	1	3	3.7
SR	-	-	1	1	-	1	2	5	6.1
NL	-	-	-	1	1	-	-	2	2.4
BN	-	-	-	2	2	3	3	10	12.2
TN	-	-	-	-	-	-	-	0 +ve	-
KK	-	-	-	-	1	1*	1*	3	3.7
KI	-	-	-	1 & 1*	1	-	1	4	4.9
GI	-	-	-	2	-	-	1	3	3.7
KN	-	-	-	-	1	3	-	4	4.9
YK	-	-	-	2	5	1	4	12	14.6
AI	-	-	-	3	1	2	5	11	13.4
MK	-	-	-	-	-	2*	1	3	3.7
HM	3	2	-	1	-	-	-	6	7.3
HQ	2	2	-	1	1	-	-	6	7.3
HB	5	2	-	-	-	-	-	7	8.5
KD	-	0	-	-	-	-	1	1	1.2
RD	-	0	-	-	1	1	-	2	2.4
SD	-	0	-	-	-	-	-	0 +ve	-
Total	10	6	3	15	14	14	20	82	
RA (%)	12.2	7.3	3.7	18.3	17.1	17.1	24.4		
RF (%)	16.7	16.7	11.11	50	50	44.4	55.5		

Korang (Rawalpindi) (KR), Swaan (Rawalpindi) (SR), Nullah Lai Rawalpindi) (NL), Badri Nullah Bridge (Swabi) (BN), Tordher Nullah (Swabi) (TN), Kabul (Kund, Nowshera) (KK), Kabul & Indus (Kund , Nowshera) (KI), Ghazi, Indus (Swabi) (GI), Kalpani Nullah (Mardan) (KN), Yar Hussain Khowar (Swabi) (YK), Allah dher, Indus (Swabi) (AI), Mardan Pull, Kabul (Nowshera) (MK), Head Marala, Chenab (HM), Head Qadir Abad, Chenab (HQ), Head Balloki, Ravi (HB), Khanpur Dam (Huri Pur) (KD), Rawal Dam (Islamabad) (RD), Simly Dam (Islamabad) (SD).

***** Those found dead during survey

+ive Turtle were reported to be found there but not during recent survey.

Table 3: Physico-chemical parameters of all water bodies during study period.

Sites	pH	TDS (mg/L)	Conductivity (mv)	DO (mg/L)	Air Temp. (°C)	Water Temp. (°C)
KR	6.90±0.12	0.93±0.01	11.67±0.88	4.50±0.29	27.33±0.33	22.33±0.88
SR	7.50±0.12	0.54±0.02	15.33±0.67	3.40±0.17	27.17±0.73	25.17±0.60
NL	8.17±0.09	1.27±0.01	26.33±0.88	2.63±0.15	25.17±0.44	24.00±1.15
BN	8.30±0.12	0.71±0.03	16.33±0.33	6.10±0.46	30.67±0.33	26.00±0.58
TN	8.63±0.09	5.07±0.14	24.33±1.20	0.67±0.09	29.17±0.17	26.80±0.92
KK	8.83±0.09	0.35±0.01	9.33±0.88	6.90±0.25	31.33±0.33	27.50±0.76
KI	8.37±0.09	0.28±0.01	7.67±0.44	7.47±0.20	31.67±0.33	27.67±0.88
GI	8.57±0.12	0.77±0.01	13.33±0.88	9.57±0.07	36.33±0.33	28.77±0.67
KN	8.53±0.18	0.47±0.02	19.33±1.45	4.80±0.21	30.33±0.33	27.17±0.44
YK	9.43±0.09	0.77±0.03	8.67±0.44	6.10±0.21	20.33±0.33	19.00±0.58
AI	8.83±0.09	0.82±0.01	7.33±0.33	5.30±0.10	26.50±0.29	24.00±0.07
MK	9.30±0.06	1.01±0.10	12.67±0.88	3.07±0.07	31.67±0.33	28.83±1.01
HM	8.37±0.12	0.28±0.01	14.33±0.33	13.23±0.15	38.67±0.33	31.83±0.44
HQ	8.53±0.18	0.97±0.02	8.67±0.60	16.40±0.23	37.67±0.33	32.17±0.44
HB	8.73±0.12	0.49±0.02	13.33±0.88	11.17±0.17	40.33±0.33	34.00±0.58
KD	8.72±0.20	0.83±0.00	8.33±0.33	8.97±0.27	27.67±0.33	22.00±0.67
RD	8.57±0.15	0.94±0.01	14.00±0.58	8.53±0.03	34.00±0.05	31.00±0.07
SD	8.43±0.09	0.73±0.00	10.67±0.88	8.67±0.09	31.67±0.33	25.27±0.37

Korang (Rawalpindi) (KR), Swaan (Rawalpindi) (SR), Nullah Lai Rawalpindi) (NL), Badri Nullah Bridge (Swabi) (BN), Tordher Nullah (Swabi) (TN), Kabul (Kund, Nowshera) (KK), Kabul & Indus (Kund , Nowshera) (KI), Ghazi, Indus (Swabi) (GI), Kalpani Nullah (Mardan) (KN), Yar Hussain Khowar (Swabi) (YK), Allah dher, Indus (Swabi) (AI), Mardan Pull, Kabul (Nowshera) (MK), Head Marala, Chenab (HM), Head Qadir Abad, Chenab (HQ), Head Balloki, Ravi (HB), Khanpur Dam (Huri Pur) (KD), Rawal Dam (Islamabad) (RD), Simly Dam (Islamabad) (SD).

Biotic Factors

During the study period (March, 2007 - July, 2008) 27 genera of phytoplankton and 16 genera of zooplankton were observed from the study sites (Table 4). Among phytoplankton Chlorophyta (12), Cyanophyta (5), Bacillariophyta (3), Chrysophyta (3), Euglenophyta (2), Xanthophyta (1) and Marchantiophyta (1) were found. Sixteen genera of zooplankton consist of Rotifera (7), Cladocera (3), Protozoa (2), Aquatic insect or Arthropoda (2) and Copepod (1). In addition to plankton a mollusc (*Pleurodiscus sp*.) was also found.

Among zooplankton Rotifera (41.40%) found most abundant has *Keratella sp*. (4.8%), *Kellicottia sp*. (4.6%), *Syncheata sp*. (8.9%), *Mytilinia sp*. (5.9%), *Barachionus sp.* (5.9%), *Gastropus sp*. (6.1%) and *Polyarthra sp*. (5.1%). Cladocera (18.71%) has *Bosmina sp*. (6.7%), *Daphnia sp*. (7.2%) and *Monia sp*. (4.8%). Aquatic arthropoda (15.14%) has Crustacean Larvae (8.1%) and *Diptychus sp*. (7.0%). Protozoan (10.31%) consists of *Amoeba sp*. (5.4%) and *Paramecium sp*. (5.0%). Copepod (9.4%) and Molluscs (5.1%) has only *Cyclops sp*. (9.34%) and *Pleurodiscus* sp. (5.1%).

Table 4. Diversity index of Phytoplankton and zooplankton in the study area during study period.

Sites	Zooplankton				Phytoplankton			
	Genera (#)	Individuals (#)	Diversity Index (H)	RA (%)	Genera (#)	Individuals (#)	Diversity Index (H)	RA (%)
KR	12	632	1.7	40.53	19	927	2.6	59.46
SR	8	281	1.2	27.3	16	749	2.3	72.7
NL	5	52	1.0	26.9	6	141	1	73.1
BN	6	100	1.0	7.8	18	1186	2.5	92.2
TN	3	16	0.7	7.9	9	186	1.5	92.1
KK	5	159	0.8	14.7	19	921	2.6	85.3
KI	12	721	1.7	42.3	16	966	2.5	57.3
GI	11	535	1.6	37.1	14	906	1.9	62.9
KN	10	529	1.4	38.2	19	858	2.7	61.8
YK	10	583	0.7	30.9	19	1302	2.5	69.1
AI	13	933	1.8	37.8	20	1534	2.6	62.2
MK	8	409	1.2	36.6	11	707	1.5	63.4
HM	7	274	1.1	43.4	14	357	2.2	56.6
HQ	8	449	1.3	46	11	528	1.6	54
HB	7	412	1.0	45.5	11	494	1.6	54.5
KD	12	756	1.7	41.3	19	1073	2.6	58.7
RD	11	778	1.5	37.2	17	1315	2.2	62.8
SD	10	828	1.3	41.4	21	1172	2.8	58.6

Korang (Rawalpindi) (KR), Swaan (Rawalpindi) (SR), Nullah Lai Rawalpindi) (NL), Badri Nullah Bridge (Swabi) (BN), Tordher Nullah (Swabi) (TN), Kabul (Kund, Nowshera) (KK), Kabul & Indus (Kund , Nowshera) (KI), Ghazi, Indus (Swabi) (GI), Kalpani Nullah (Mardan) (KN), Yar Hussain Khowar (Swabi) (YK), Allah dher, Indus (Swabi) (AI), Mardan Pull, Kabul (Nowshera) (MK), Head Marala, Chenab (HM), Head Qadir Abad, Chenab (HQ), Head Balloki, Ravi (HB), Khanpur Dam (Huri Pur) (KD), Rawal Dam (Islamabad) (RD), Simly Dam (Islamabad) (SD).

Phytoplanktons found most abundant as compared to zooplanktons in study area. Chlorophyta (46.13%) was relatively abundant as compared to all other phyla and has *Actinospharium sp.* (5.8%), C*hlamydomonas sp.* (4.8%) *Coelastrum sp.* (2.7%), *Eudorina sp.* (5.5%), *Oophila sp.* (4.9%), *Pediastrum sp.* (5%), *Spirogyra sp.* (4.5%), *Sorastrum sp.* (2.7%), *Microspora sp.* (1.4%), *Uronema sp.* (3.4%), *Volvox sp.* (2.5%) and *Ulothrix sp.* (2.9%). Cyanophyta (18.10%) has *Anabena sp.* (4.9%), *Chroococcoccus turgid* (3.6%), Microcystis colonies (4.1%), *Nostoc sp.* (2.6%), *Xenococcus sp.* (2.9%). Phylum Bacillarophyta (11.10%) has *Synedra sp.* (3.6%), *Melosira sp.* (3.2%), *Gyrosigma sp.* (4.3%). Chrysophyta (8.29%) has *Chyrococcus sp.* (2.1%), *Mallomonas sp.* (3.8%) and *Tribonema sp.* (2.4%). Euglenophyta (9.25%) has *Euglena sp.* (5.0%) and *Cyclotella sp.* (4.2%). The least abundant Xanthophyta (3.73%) and Marchantiophyta (3.37%) has *Ophicytium sp.* (3.7%) and *Monocilia sp.* (3.4%), respectively.

Among zooplankton, Rotifera and Protozoan were most common and were present throughout the study area except Tordher Nullah (Swabi) (TN) and Badri Nullah Bridge (Swabi) (BN), respectively. The members of Copepoda were not found at Nullah Lai Rawalpindi) (NL), TN, Kabul (Kund, Nowshera) (KK), Ghazi, Indus (Swabi) (GI) and Khanpur Dam (Huri Pur) (KD). Aquatic Insecta (Arthropoda) were not found at Swaan (Rawalpindi) (SR), TN and Head Qadir Abad, Chenab (HQ) while Cladocera were not observed at NL, TN, KK and Head Marala, Chenab (HM). Mollusca found only at SR, TN, Kabul & Indus (Kund, Nowshera) (KI), GI, Kalpani Nullah (Mardan) (KN), Allah Dher, Indus (Swabi) (AI), Mardan Pull, Kabul (Nowshera) (MK) and KD. Among phytoplankton genus, Chlorophyta, Cyanophyta, Bacillariophyta and Chrysophyta has been found throughout the study area. The members of Euglenophyta were present in all samples except at NL and BN. At SR, NL, TN, GI, Yar Hussain Khowar (Swabi) (YK), HQ, Head Balloki, Ravi (HB) and Rawal Dam (Islamabad) (RD) Xanthophyta were not observed. Similarly, Marchantiophyta were not found at SR, NL, TN, KK, YK, MK, HM and HB.

Diversity index of phytoplankton ranges from 1 to 2.8. It is minimum at NL and maximum at Simly Dam (Islamabad) (SD) as shown in Table 4. Twelve out of 18 sites showed diversity index of phytoplankton above 2 while five sites have 1.5 or more diversity index value for phytoplankton. Similarly, Diversity index of zooplankton ranged from 0.7 to 1.8 as given in Table 4. It is minimum at TN and YK and maximum at AI. Five out of 18 sites have shown 1.5 or more diversity index value while 10 sites have diversity index value between 1 and 1.5 for zooplankton. Only three sites have less than 1 value for diversity index of zooplankton.

During the present study it is also recorded that phytoplankton were most abundant as compared to zooplankton. The reason for that trend well reported in literature because of the fact that phytoplankton are found at the surface of water and zooplankton below primarily due to photosynthesis. Phytoplankton abundance during the present was mainly because of the sampling being conducted during day time. The value diversity index (H) on all sites for phytoplankton was 1.0 or above 1.0 which showed that all water bodies were productive and can support the food web. Similarly, the diversity index for Zooplankton remained 1.0 or above except only three sites at TN, KI and YK (0.7, 0.7

and 0.8). As a result of diversity index the value below 1.0 indicates the low quality of water body and less supportive to the life of zooplankton (Williamson *et al*., 1996).

The presence of different freshwater turtle species in all water bodies supported by the water quality parameters studied during the present work. While only one site Yar Hussain Khuwar, Swabi (YK) which is less supportive for the zooplankton suggested that the freshwater turtles adapted well to those water bodies. It was already an established fact that freshwater turtles are scavengers and adapted well to live in the cosmopolitan ponds (Khan, 2006).

CONCLUSION

Hence concluded freshwater turtles are important natural resources of the country, should be given legal coverage and conservation measures should be taken to avoid freshwater turtle's species extinction. Exceptional interventions should be employed for those sites where turtle's population is very scarce. As a results of the current study suggested that preferred physical features of habitats should be taken into consideration for establishing artificial habitats and pond culture for breeding purpose and during unfavourable environmental conditions. Therefore following recommendations are suggested:

1. To study their natural history, breeding and feasibility of farming research studies should be arranged under Wildlife and Fisheries departments of province in Pakistan.
2. Legislation should also be made to stop their illegal hunting and export
3. Farming should also be encouraged for their legal export and captive breeding.
4. Awareness may be created among people to protect the various turtle species.

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